1M1

UNIVERSITY OF ARKANSAS
COLLEGE OF AGRICULTURE

Agricultural Experiment Station

Main Station, University; with Cotton Branch Station, [illegible]
Rice Branch Station, Arkansas County; Fruit [illegible]
Truck Branch Station, Hempstead County

IMPERIAL MYCOLOGICAL INSTITUTE
13 AUG. 1932

COTTON WILT STUDIES

IV. EFFECT OF FERTILIZERS ON COTTON WILT

V. H. YOUNG, GEO. JANSSEN and J. O. WARE

BULLETIN NO. 272

DAN T. GRAY, Director

FAYETTEVILLE, ARKANSAS

MAY, 1932

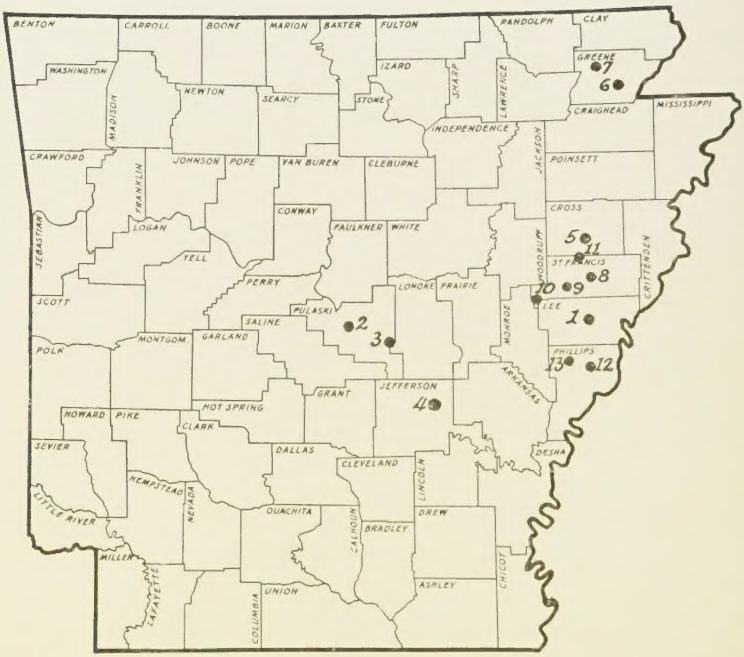

Figure 1. Map of Arkansas showing location of 3-year study at Cotton Branch Experiment Station in Lee County 1929-1931, and of the fertilizer tests in various counties studied in 1930 and 1931; (1) Cotton Branch Experiment Station near Marianna, (2) North Little Rock, (3) Scott, (4) Altheimer, (5)Wynne, (6) Paragould, (7) Beech Grove, (8) Forrest City, (9) Palestine, (10) Wheatley, (11) Colt, (12) Barton, (13) Marvell.

COTTON WILT STUDIES

IV. EFFECT OF FERTILIZERS ON COTTON WILT

By V. H. YOUNG, GEO. JANSSEN[1], and J. O. WARE

Departments of Plant Pathology and Agronomy

CONTENTS

	Page		Page
Method of study	6	Supplementary data from various tests in central, eastern, and northeastern Arkansas	15
Presentation of results	8	Comparison of results	21
Results at the Cotton Branch Experiment Station	8	Summary and conclusions	24

Since Atkinson (1892) first called attention to cotton wilt in Alabama, its prevalence has been noted in certain light soils, especially sandy alluvial soils and the so-called "sand blows". The idea that cotton wilt is in a certain measure at least favored by deficiencies in the soil no doubt arises from the fact that it is often most severe in those sandy soils which are lacking in organic matter and in certain mineral nutrients. From time to time benefit has been reported from the use of various types of fertilizers for cotton wilt control, and many practical growers and plant pathologists have advocated the use of fertilizers for that purpose. Others, especially in the Carolinas, Georgia and Florida, have reported little or no benefit from fertilizers, particularly mineral fertilizers.

Fulton (1907) noted that the presence of diseased stalks in the field and the use of manure inoculated with the cotton wilt organism increased the incidence of the pathogen in the soil, but he says that "the condition of the soil has another indirect bearing on the wilt problem growing out of the important part the soil plays in the production of vigorous cotton plants that can ward off disease. Along this line it has been shown that the use of stable manure on wilt-infested lands results in a very marked decrease in the loss from wilt, as well as in the increase in the productiveness of the stalks generally." Fulton noted twice as much loss from cotton wilt on unmanured plots as on plots manured at the rate of 30 loads per acre. He noted further that cowpeas and other legumes used as a green manure had a similar though less marked effect, and that commercial mineral fertilizers had no effect on the incidence of cotton wilt.

Orton (1907) found that with Sea Island cotton "Wilt is

[1]Deceased, Jan. 31, 1932.

most prevalent on sandy or sandy loam soils best suited for Sea Island cotton" and that "Low spots and rich bottom lands often escape the disease long after the cotton on the higher portions of the field is killed". According to Orton "Wilt is not due to the continual use of commercial fertilizers, nor to the exhaustion of any element of plant food". He further noted that "The free use of stable manure will assist in the control of wilt by increasing the vigor of resistant varieties" but that "ordinary non-resistant kinds are not sufficiently protected by stable manure". Orton noted also the beneficial effect of plowing under leguminous crops and compost.

Orton (1908) stated that the cotton wilt is perhaps worse in soils lacking organic matter, although it may be very serious in rich and heavily manured land. Efforts to remedy wilt by the use of green manures were found to generally result in an increase in the amount of the disease because of the root-knot susceptible varieties of cowpeas often used for this purpose. According to Orton, the greatly increased incidence of root-knot in cotton resulting from this practice breaks down its resistance to the cotton wilt pathogen and much more severe attacks of cotton wilt result. He notes further, "Wilt is less injurious to cotton on low land or in low spots in a field. These are richer in organic matter and are also wetter. Probably both factors are involved". He noted also that wilt had not been observed in black prairie soils, and stated that no benefit from the use of any type of commercial fertilizer had been found. Referring to the use of stable manure he said, "Our experience has been that in slightly infected fields this does give some relief, but the wilt takes the field in the end in spite of the heaviest manuring."

Lewis (1911) reported that field studies during seasons from 1905 to 1910 gave no indication that fertilizer, whether consisting of inorganic substances, a combination of organic and inorganic substances, or a combination of fertilizer and lime, gave any definite results so far as the control of cotton wilt was concerned. He said, "Thus it will be noticed on the unfertilized plots from 75 to 92 per cent of the plants died, while on the fertilized from 72 to 90 per cent of the cotton died." He further said, "We would especially call attention to the fact that muriate of potash was of no benefit in controlling the disease." Lewis made note of the well known effect of root-knot in increasing the severity of cotton wilt attacks. He stated that chemical analyses of soil from a field at Zellobee, Georgia, badly affected with cotton wilt indicated no deficiency except that of lime. Addition of lime to this soil did not decrease the incidence of cotton wilt.

Rast (1922) found that the addition of 500 pounds of kainite containing 12.5 per cent of potash to 500 pounds of a mixed fertilizer containing 10 per cent available phosphoric acid and 3 per cent of nitrogen gave almost complete control of cotton wilt

whereas "By harvest time, no less than 95 per cent of the plants on the unfertilized area were dead." In the previous year, the same area had been fertilized with the same fertilizer with the exception that kainite was not used, the fertilizer being free of potash. He states that the cotton plants on both fertilized and unfertilized portions of the field "died so badly that no record was kept of the yield of cotton produced." Other work indicated that the addition of 500 pounds of kainite to land fertilized with nitrogen and phosphorus after the plants were up and growing gave equally good results in the control of cotton wilt.

Fahmy (1927) found that the cotton wilt disease in Egypt is more serious on the heavier fertile soils of the Delta and that the use of stable manure tends to increase the incidence of the disease, rather than decrease it.

Neal (1927) reported work carried on in 1925 and 1926 on the relation of fertilizers to the development of cotton wilt. He grew cotton in washed sand with various nutrient solutions in which phosphorus, potassium, and calcium were individually omitted. Increased amounts of phosphorus and potassium were also used in certain experiments, and the effect of increasing and decreasing the amount of nitrogen was also tried. Iron and aluminum salts were also added in some cases. No consistent effects on the incidence of cotton wilt could be noted, except with those cultures having increased amounts of potassium, with those from which calcium was omitted, and with those having a high iron content. Field experiments gave some indications that potash may control wilt.

Rosen (1927) called attention to discrepancies in the results obtained by Orton *(loc. cit.)* and Fulton *(loc. cit.)* and to the possibility of cotton wilt control through the use of organic fertilizers.

Neal (1928) gave the result of further field studies at A. and M. College, Mississippi, and the South Mississippi Branch Station at Poplarville, Miss. The results over a 2-year period showed a marked diminution in the incidence of cotton wilt when fertilizers were used, particularly those containing some form of potash. At Poplarville it was found that plots receiving only nitrogen and phosphorus developed almost as much wilt as those that received no fertilizer whatsoever and that those receiving kainite and muriate of potash were outstanding from the point of view of the reduction of cotton wilt.

Neal (1928) stated that further work with fertilizers for the control of cotton wilt showed that "Fertilizers high in nitrates and potassium have uniformly given a lesser amount of infection on inoculated soil."

Miles (1929) in continuation of the work begun by Neal *(loc. cit.)* emphasized the value of adequate nutrition for the control of cotton wilt. He stated that "Fertilizers high in potassium and

nitrates have uniformly given a lesser amount of infection on inoculated soil than where the above mentioned elements are in properly balanced relationship. A high percentage of either with a low percentage of the other has failed in each case to give as effective control". Again in 1930 Miles emphasized the value of a balanced fertilizer in the control of cotton wilt, but states further that a deficiency in potash seems to be much more disastrous than a corresponding deficiency in nitrogen.

Young, Ware, and Janssen (1929) reported the ineffectiveness of legumes used as green manures and of calcium nitrate, when used in pot experiments in the greenhouse for the control of cotton wilt.

Walker (1930) reported that potassium sulphate used in varying amounts in a complete fertilizer on land near Gainesville, Florida, that was badly infested with the cotton wilt organism, was ineffective in bringing about the control of cotton wilt. Neither unfertilized plots nor plots in which potash alone was omitted were included in the experiments. The incidence of cotton wilt was extremely high, amounting to from 58 to 90 per cent in different tests. No yield records were secured and no mention is made as to whether the soil was sufficiently deficient in potash so that any growth response with cotton resulted from its application.

Young, Ware, and Janssen (1930) stated that work at the Cotton Branch Experiment Station in Lee County, Arkansas, in 1929 gave some indication that potash-containing fertilizers may be of some importance in controlling cotton wilt. These writers (1931) stated that work conducted at the same place in 1930 gave definite confirmation of the 1929 results, which indicated that under the conditions of the experiment potash applications in the form of kainite or muriate of potash greatly reduced the incidence of cotton wilt, and that mineral fertilizers not containing potash, and applications of cottonseed meal were ineffective in cotton wilt control. Data tending to confirm the results obtained at the Cotton Branch Experiment Station were secured from counts made on fertilizer tests located in central, eastern, and northeastern Arkansas. Pot studies at the Main Station at Fayetteville in part confirmed the field results just mentioned, but when Clarksville silt loam, which by analysis was found to contain relatively high amounts of potassium naturally, was used in these studies, only neutral data were secured.

Methods of Study

The data reported in this bulletin were secured from field experiments conducted during the seasons of 1929, 1930, and 1931 on land closely adjacent to the Cotton Branch Experiment Station in Lee County. Certain supplementary data are also in-

cluded from counts made in 1930 and 1931 on various fertilizer tests located in central, eastern, and northeastern Arkansas. The methods used in securing these latter counts will be described briefly in connection with the presentation of results.

The land employed for the experiments in Lee County consisted of a fairly uniform Lintonia silt loam soil, approximately 1⅓ acres in area. It had been planted to cotton over a period of years, and observations made in 1927 and 1928 indicated that severe losses from cotton wilt were being experienced. Furthermore, cotton wilt was found to be uncomplicated by the presence of root-knot or nematode disease, but the cotton was found to be suffering to a certain degree from potash hunger or "rust".

In order to study the effects of single salts and of various combinations of salts, commercial mixed fertilizers were not used but instead sodium nitrate, superphosphate, kainite, and muriate of potash were used singly or in combination as the case might be. Cottonseed meal was used as an organic fertilizer. Four one-thirtieth-acre plots distributed throughout the experimental field were employed for each treatment, and there were four unfertilized check plots of the same area. Each plot was separated from each other plot by an untreated buffer row. Data have also been secured from buffer rows.

The arrangement of the plots and the fertilizer treatments was followed throughout the 3 years of the experiment. Permanent landmarks were set in order that each row might occupy the same exact site each year. The arrangement of the plots and the fertilizer treatments are as follows: Plot No. 1, nitrate of soda, 300 pounds per acre; Plot No. 2, nitrate of soda, 150 pounds per acre; Plot No. 3, check, no fertilizer; Plot No. 4, kainite, 1,080 pounds per acre; Plot No. 5, muriate of potash, 300 pounds per acre; Plot No. 6, nitrate of soda, superphosphate, and muriate of potash, 150 pounds, 312 pounds, and 40 pounds per acre, respectively; Plot No. 7, superphosphate, 312 pounds per acre, and muriate of potash, 40 pounds per acre; Plot No. 8, nitrate of soda, 150 pounds per acre, and muriate of potash, 40 pounds per acre; Plot No. 9, nitrate of soda, 150 pounds per acre, and superphosphate, 312 pounds per acre; and Plot No. 10, cottonseed meal, 600 pounds per acre. Each plot was separated from the preceding and succeeding plots by a buffer row. There were four series of all treatments and of checks.

The plan of fertilization involved the use of relatively high amounts of nitrogen and potash alone, the application of an entirely organic fertilizer in the form of cottonseed meal, and the use of a complete fertilizer approximating a 4-10-4 (NPK) mixture and other mixtures similar to the complete fertilizer, except that one of the three elements (NPK) was omitted in each case. Potash was applied alone in the form of muriate of potash and kainite, the amounts of kainite being adjusted to supply an

amount of potash equal to that supplied by the muriate of potash. Five hundred pounds of a 4-10-4 mixture closely follows a common recommendation for cotton fertilization in Arkansas. The fertilizer was applied in the furrow under the bed. In 1929 it was applied at the time of planting, but in 1930 and 1931 it was applied well in advance of planting. Trice 304, a variety of cotton highly susceptible to cotton wilt, was used the 3 years, except in 1929 when a faulty stand occurred and a sufficient amount of seed of Trice 304 was not available, series II and IV were replanted that year with Misdel 2, another variety highly susceptible to the disease.

Each year the cotton was chopped and cultivated according to standard methods employed at the Cotton Branch Experiment Station. After chopping, the original stand count was taken, and wilt counts were made at regular dates during the growing season. Plants which were so badly affected at the time of counting that it seemed likely they would have completely disappeared before the next wilt count was made were removed and so recorded in the notes. The final wilt count at the end of the season, therefore, included all plants affected with wilt at that time, plus all plants affected with wilt and removed prior to that time. Diagnosis in all doubtful cases was made by cutting into the stem near the base of the plant and looking for the typical vascular discoloration.

Notes were taken on the effect of the various treatments on the vegetative condition of the crop, especially with respect to potash hunger or "rust", and yield records were secured by making three pickings as is customary with other experimental work with cotton. The percentage of earliness was computed from the yield records by determining the percentage of the total yield represented by the first picking. Under normal conditions where disease is not an important factor, the percentage of earliness gives an excellent method of comparing the earliness of different cotton varieties. In this particular work, it tended to show the effect of cotton wilt and potash hunger in bringing about the early death of the plants and in practically eliminating the formation of any late or top bolls.

Presentation of Results

Results at the Cotton Branch Experiment Station, 1929-31. All data with respect to percentages of wilt throughout the season and with respect to yields have been kept row by row, but as it has not seemed feasible to present such detailed data here, only complete data from the respective treatments are given. The results for 1929 are given in Table 1.

As will be seen from Table 1, cotton wilt was present in small amounts by July 9 in all of the plots, but differences in the various plots were so slight as to be entirely within the range of

TABLE 1. EFFECT OF VARIOUS FERTILIZER TREATMENTS ON INCIDENCE OF COTTON WILT, YIELD OF SEED COTTON, AND PERCENTAGE OF EARLINESS. COTTON BRANCH EXPERIMENT STATION, LEE COUNTY, ARKANSAS, 1929. (TOTAL PLANT COUNT 11,446.)

Plot treatment	Cotton wilt July 9	Cotton wilt Aug. 14	Cotton wilt Sept. 1 (final)	Yield seed cotton per acre	Earliness
	Per cent	*Per cent*	*Per cent*	*Pounds*	*Per cent*
Nitrate of Soda—300 lbs. per A.	2.76	19.4	30.4	340	52.3
Nitrate of Soda—150 lbs. per A.	3.60	27.9	40.9	317	43.8
Check, no fertilizer	1.76	18.2	30.3	237	49.7
Kainite—1,080 lbs. per A.	.87	2.8	6.0	701	17.9
Muriate of Potash—300 lbs. per A.	2.71	7.4	13.9	580	22.6
Nitrate of Soda—150 lbs. per A. Superphosphate—312 lbs. per A. Muriate of Potash—40 lbs. per A.	1.5	14.2	24.9	517	46.2
Superphosphate—312 lbs. per A. Muriate of Potash—40 lbs. per A.	2.3	16.2	26.9	446	39.5
Nitrate of Soda—150 lbs. per A. Muriate of Potash—40 lbs. per A.	1.7	13.3	28.9	482	41.7
Nitrate of Soda—150 lbs. per A. Superphosphate—312 lbs. per A.	3.5	28.1	43.8	344	54.6
Cottonseed Meal—600 lbs. per A.	3.3	31.4	40.6	332	50.3
Buffer rows	3.3	22.6	36.0	298	39.7

experimental error. By Aug. 14, however, differences were clear cut, the incidence of cotton wilt in the plots treated with kainite being only 2.8 per cent and in the plots treated with 300 pounds of muriate of potash alone 7.4 per cent, in contrast to more than 31.4 per cent in the plots fertilized with cottonseed meal. All plots fertilized with potash, including those on which only 40 pounds per acre was used, appeared at this time to be in better condition than other plots and showed less "rust" or potash hunger. By September 1, when the last counts were made, the differences were outstanding with respect to incidence of cotton wilt, size and color of plants, and presence of potash hunger. The plants in the plots receiving kainite and 300 pounds of muriate of potash in particular were decidedly taller and greener and were still setting bolls, whereas the checks and non-potash plots had reached maturity and the leaves had the typical bronze appearance of potash-hungry plants. Although all plots receiving potash showed less cotton wilt than other plots, the differences were not sufficiently great, except for the plots fertilized at the rate of 1,080 pounds of kainite per acre and 300 pounds of muriate of potash per acre, to warrant any definite conclusions. The results for the high potash plots were outstanding and were reflected in very much increased yields. Heavy applications of

nitrate of soda alone seemed wholly inefficient with respect to the control of both cotton wilt and rust, and the same may be said for cottonseed meal at the rate applied.

The columns in Tables 1, 2 and 3 headed "earliness" show the percentage of the total amount of seed cotton secured in the first picking. These data in 1929 apparently indicate that the high potash plots were very much delayed in maturing their crop, but this delay is more apparent than real, since at the first picking these plots produced more cotton than the checks and only slightly less than all of the other plots, excepting the complete fertilizer plots which produced nearly a half again as much cotton at the first picking as any other plots. What actually

TABLE 2. EFFECT OF VARIOUS FERTILIZER TREATMENTS ON INCIDENCE OF COTTON WILT, YIELD OF SEED COTTON, AND PERCENTAGE OF EARLINESS. COTTON BRANCH EXPERIMENT STATION, LEE COUNTY, ARKANSAS, 1930. (TOTAL PLANT COUNT 33,899.)

Plot treatment	Cotton wilt July 3	Cotton wilt Aug. 5	Cotton wilt Sept. 1 (final)	Yield seed cotton per acre	Earliness
	Per cent	*Per cent*	*Per cent*	*Pounds*	*Per cent*
Nitrate of Soda—300 lbs. per A.	.5	2.5	15.5	401	53.5
Nitrate of Soda—150 lbs. per A.	.9	3.9	23.9	347	89.0
Check, no fertilizer	1.2	2.8	22.3	282	90.4
Kainite—1,080 lbs. per A.	.2	.2	2.9	674	83.1
Muriate of Potash—300 lbs. per A.	.1	.3	4.9	617	85.9
Nitrate of Soda—150 lbs. per A. Superphosphate—312 lbs. per A. Muriate of Potash—40 lbs. per A.	.7	1.7	9.6	613	89.6
Superphosphate—312 lbs. per A. Muriate of Potash—40 lbs. per A.	.7	1.3	10.1	456	91.4
Nitrate of Soda—150 lbs. per A. Muriate of Potash—40 lbs. per A.	.7	1.6	10.5	415	88.8
Nitrate of Soda—150 lbs. per A. Superphosphate—312 lbs. per A.	.9	3.1	20.2	330	91.8
Cottonseed Meal 600 lbs. per A.	1.1	4.5	21.9	392	88.0
Buffer Rows	.9	2.3	17.7	356	88.9

happened was that the high potash plots retained their foliage much later than the other plots and continued to mature bolls until late in the season, whereas those plots with large numbers of plants affected with cotton wilt and potash hunger yielded much less cotton after the first picking and, therefore, were apparently much earlier in maturing.

The season of 1930 will go down in history as witnessing one of the most severe droughts ever encountered in Arkansas, and the results shown in Table 2 for that year are, therefore,

abnormal in many respects. Yields in some cases, were somewhat lower than in 1929 and decidedly lower than in 1931, when yields were exceptionally high. The incidence of cotton wilt was considerably less than in 1929 in all the experimental plots as well as in commercial plantings, and the incidence and effects of potash hunger seemed to have been greatly increased. However, all plots of the experiment receiving potash had appreciably smaller amounts of wilt than did other plots, and the high potash plots were again outstanding in this respect, as well as in their lack of potash hunger and in increased yields (Figure 2). Fairly heavy applications of nitrate alone, applications of

Figure 2. Effect of heavy application of kainite (kainite plot right, buffer row center, and unfertilized check left). Cotton Branch Experiment Station, Lee County, Arkansas. September 1930. Note increased vigor, healthy foliage, and uninterrupted stand in the kainite plot. Only 2.9 per cent of the plants were affected with cotto wilt in the kainite plots in contrast to 17.7 per cent in the buffer rows, and 22.3 per cent in the unfertilized check. Note also absence of symptoms of "rust" in kainite plot.

nitrate and phosphate together, and applications of cottonseed meal were ineffective in 1930 as in 1929 in the control of cotton wilt. The observation that the high potash plots seemed to withstand the effects of the extremely dry season better was made but needs substantiation by many more observations.

The season of 1931 was unusually favorable for cotton all over the South and yields were exceptionally high (Table 3). Cotton wilt was somewhat more prevalent than in 1930, but not so prevalent as in 1929. "Rust", or potash hunger, was as important as in the average year but less so than in 1930. The potash plots were again outstanding with respect to the presence of cotton wilt. Little difference could be noted on June 10 when the

TABLE 3. EFFECT OF VARIOUS FERTILIZER TREATMENTS ON INCIDENCE OF COTTON WILT, YIELD OF SEED COTTON, AND PERCENTAGE OF EARLINESS. COTTON BRANCH EXPERIMENT STATION, LEE COUNTY, ARKANSAS, 1931. (TOTAL PLANT COUNT 37,834.)

Plot treatment	Cotton wilt June 10	Cotton wilt July 11	Cotton wilt July 29	Cotton wilt Aug. 21	Cotton wilt Sept. 8 (final)	Yield seed cotton per acre	Earliness
	Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Pounds*	*Per cent*
Nitrate of Soda—300 lbs. per A.	.9	3.4	6.4	14.2	21.3	1,196	35.7
Nitrate of Soda—150 lbs. per A.	.9	4.5	7.5	15.7	21.1	1,153	33.8
Check, no fertilizer	1.5	6.3	9.6	14.5	18.7	769	52.0
Kainite—1,080 lbs. per A.	.3	2.6	3.2	3.8	5.2	1,631	23.7
Muriate of Potash—300 lbs. per A.	.3	1.5	2.9	4.2	4.9	1,383	24.1
Nitrate of Soda—150 lbs. per A. Superphosphate—312 lbs. per A. Muriate of Potash—40 lbs. per A.	1.0	4.0	5.9	9.3	12.8	1,700	37.0
Superphosphate—312 lbs. per A. Muriate of Potash—40 lbs. per A.	.9	3.7	6.3	9.5	12.0	1,269	49.3
Nitrate of Soda—150 lbs. per A. Muriate of Potash—40 lbs. per A.	.5	2.7	4.6	9.1	11.6	1,432	33.7
Nitrate of Soda—150 lbs. per A. Superphosphate—312 lbs. per A.	.7	4.7	8.9	18.2	23.5	1,032	51.9
Cottonseed Meal—600 lbs. per A.	1.9	9.7	13.4	20.1	26.2	1,260	30.4
Buffer Rows	.9	3.5	6.4	9.8	18.6	622	40.4

first counts were made, nor did the differences appear so outstanding by July 11 when the second counts were made, but by the last of July the differences were clear cut and remained so, as shown by the last count made on September 8. Yields were appreciably higher on all plots receiving potash, but the complete fertilizer plots gave a somewhat better yield than the high potash plots in 1931. The high potash plots were again outstanding with respect to the control of cotton wilt and "rust," or potash hunger. Again heavy applications of nitrate of soda and of cottonseed meal appeared ineffective.

In 1930 all plots matured very early because of the excessively dry conditions, but in 1931 the high potash plots in particular appeared from the data to have matured their cotton very late. The high total yield from these plots indicated, however, that as in 1929 the effect of potash in heavy applications was to increase the size of second and third pickings rather than to decrease the size of the first. Large amounts of cotton wilt and potash hunger in a field result in an apparent earliness which is the outcome of a cessation of growth after the first bolls have matured rather than the result of maturing a full top as well as a bottom crop of bolls.

For the sake of comparison, the final percentages of cotton wilt, the yields of seed cotton per acre, and the percentages of earliness for the 3 years are assembled in Table 4. An attempt is also made to derive averages from the figures for the 3 years, although it is of course recognized that mathematically such averages cannot be considered as strictly correct. However, since the percentages of cotton wilt in the high potash plots did not vary greatly from year to year, the average percentage of cotton wilt for the 3 years still shows that the high potash plots were outstanding with respect to cotton wilt control and yield, and that other plots containing potash appeared to have less cotton wilt, although with them differences are not sufficiently outstanding to allow any definite conclusions.

As will be noted from a comparison of yields in 1929, 1930, and 1931 of the kainite and muriate of potash plots as shown in Table 4, the yield of the kainite plots was consistently higher each year than that of the muriate of potash plots, although the amount of potash applied was actually the same. In 1929 the incidence of cotton wilt in the kainite plots was only 6 per cent, as compared to 13.9 per cent in the muriate of potash plots. Over the 3-year period, however, the average percentage of cotton wilt in the kainite plots was 4.7 as compared to 7.9 in the muriate of potash plots. The difference in the 3-year period is not sufficiently great to warrant any conclusion with respect to the effect of the two substances on the incidence of cotton wilt, but the higher yields of the kainite plots throughout the 3-year period are fairly definite. Throughout the 3-year period the cotton on

TABLE 4. EFFECT OF VARIOUS FERTILIZER TREATMENTS ON INCIDENCE OF COTTON WILT, YIELD OF SEED COTTON, AND PERCENTAGE OF EARLINESS. SUMMARY OF RESULTS AT COTTON BRANCH EXPERIMENT STATION, LEE COUNTY, ARKANSAS, 1929-1931. (TOTAL STAND OF PLANTS 83,179.)

Plot treatment	Cotton wilt (final)				Yield seed cotton per acre				Earliness			
	1929	1930	1931	Aver.	1929	1930	1931	Aver.	1929	1930	1931	Aver.
	Per cent	*Per cent*	*Per cent*	*Per cent*	*P'nds*	*P'nds*	*P'nds*	*P'nds*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
Nitrate of Soda—300 lbs. per A.	30.4	15.5	21.3	22.4	340	401	1,196	646	52.3	53.5	35.7	47.2
Nitrate of Soda—150 lbs. per A.	40.9	23.9	21.1	28.6	316	347	1,153	605	43.8	89.0	33.8	55.5
Check, no fertilizer	30.3	22.3	18.7	23.7	237	282	769	429	49.7	90.4	52.0	64.0
Kainite—1,080 lbs. per A.	6.0	2.9	5.2	4.7	700	673	1,631	1,001	17.9	83.1	23.7	41.6
Muriate of Potash—300 lbs. per A.	13.9	4.9	4.9	7.9	580	616	1,383	860	22.6	85.9	24.1	44.2
Nitrate of Soda—150 lbs. per A. Superphosphate—312 lbs. per A. Muriate of Potash—40 lbs. per A.	21.9	9.6	12.8	15.7	517	613	1,700	943	46.2	89.6	37.0	57.6
Superphosphate—312 lbs. per A. Muriate of Potash—40 lbs. per A.	26.9	10.1	12.0	16.3	446	456	1,269	724	39.5	91.4	49.3	60.1
Nitrate of Soda—150 lbs. per A. Muriate of Potash—40 lbs. per A.	28.9	10.5	11.6	17.0	482	415	1,432	776	41.7	88.8	33.7	54.7
Nitrate of Soda—150 lbs. per A. Superphosphate—312 lbs. per A.	43.8	20.2	23.5	29.1	343	330	1,032	568	54.6	91.8	51.9	66.1
Cottonseed Meal—600 lbs. per A.	40.6	21.9	26.2	29.5	332	392	1,260	661	50.3	88.0	30.4	56.2
Buffer Rows	36.0	17.7	18.6	24.1	298	356	622	425	39.7	88.9	40.4	56.3

the kainite plots seemed to be somewhat larger and slightly more resistant to "rust" or potash hunger than on the muriate of potash plots. Whether or not these differences would continue to appear over a long period is difficult to say. Kainite is a natural mineral containing several salts in addition to potash salts, and it seems not impossible that these may have been effective in stimulating the cotton plant.

Many cotton growers, particularly in the Arkansas River Valley in Arkansas, believe that kainite is more efficient than muriate of potash for the control of "rust" and cotton wilt, but preliminary trials made at the Cotton Branch Experiment Station in 1931 with purified salts comparable to those found in kainite, used separately and in combination, gave negative results, but more work in this connection is contemplated.

Supplementary data from various fertilizer tests in central, eastern, and northeastern Arkansas, 1930 and 1931. The results of the work at the Cotton Branch Station in 1929 were so promising from the point of view of the efficiency of potash fertilizers for the control of cotton wilt and "rust" that it seemed desirable to make some attempt to see whether or not comparable results could be obtained in other parts of the state. Since it was not feasible to conduct extensive tests elsewhere than at the Cotton Branch Station, it was decided, if possible, to attempt to secure data from various fertilizer tests that were being conducted in several parts of the state, especially those on certain alluvial soils where cotton wilt and potash hunger were an important factor (Figure 1). The authors had no part in the planning or carrying out of these tests, but a study of the plans followed, together with field observations and a study of yield records, indicates that the work was carefully planned and conducted throughout.[2]

It was not possible to make counts throughout the season as had been done at the Cotton Branch Station, and, since the counts were made in the latter part of August or in September, many plants affected early in the season with the cotton wilt disease were undoubtedly lost. The method employed was to count the plants in equal areas from each fertilizer treatment, and then cut into the stem of all doubtful plants near the soil line to determine whether the typical darkening of the wood was present. Of course, with many plants that were obviously diseased a slight cut or break near the top of the plant sufficed to show that the typical vascular discoloration was present. In each case a sufficient number of plants were dug to determine whether root-knot was a complicating factor. Notes were also taken on the varieties used, on the soil type, on the presence or

[2]The authors acknowledge the cooperation of Mr. Earl Kilpatrick of Marianna, Ark., who made it possible to secure data on these fertilizer tests both in 1930 and 1931, and who also provided the photographs used in this bulletin.

absence of potash hunger, and on the effect of the treatment on plant growth, and arrangements were made to secure yield records from each demonstration visited.

The first counts in 1930 were made on fertile sandy Arkansas River bottom land near North Little Rock, Arkansas. Little or no potash hunger was present, but as will be seen from Table 5, Section A, cotton wilt was present in somewhat large amounts.

TABLE 5. EFFECT OF FERTILIZER TREATMENTS ON THE INCIDENCE OF COTTON WILT AND ON THE YIELD OF SEED COTTON; DATA SECURED FROM COUNTS MADE ON FERTILIZER TESTS IN CENTRAL, EASTERN AND NORTHERN ARKANSAS, 1930[1]

Treatment	Plant count	Rate of cotton wilt	Yield of seed cotton per acre
	Number	*Per cent*	*Pounds*
Section A[2]			
Check, no fertilizer	753	36.39	609
6-8-0	1,017	35.00	960
6-8-4	971	35.20	888
6-8-8	927	41.20	738
6-8-12	1,217	26.40	987
Section B[3]			
6-8-0	384	11.98	384
6-8-12	344	0.58	726
Section C[4]			
6-8-0	176	19.30	531
6-8-12	180	1.10	825
Section D[5]			
6-8-0	430	54.00	927
6-8-12	420	21.00	1,431
Section E[6]			
Check, no fertilizer	683	18.45	558
6-8-0	601	23.79	738
[illegible]	761	13.53	774
[illegible]	636	6.45	672
[illegible] 12	829	3.25	810
Section F[7]			
Check, no fertilizer	660	19.91	642
6-8-4	787	24.02	684
6-8-12	809	25.96	930

[1]All fertilizer applications were at the rate of 600 pounds per acre placed in the rows. Counts were made August 20, 21, 29, and 30, 1931.

[2]H. K. Thatcher farm, North Little Rock, Ark. Very sandy Arkansas river bottom soil. No potash hunger, or "rust" noted; growth of cotton excellent, but practically all plants affected with wilt also affected with root-knot or nematode disease. Variety: Arkansas Rowden 2119.

[3]Jim Ray farm, Scott, Ark. Sandy Arkansas river bottom soil; potash hunger very pronounced on no-potash and low potash plots, but was largely controlled on the higher potash plots; no root-knot found. Variety: Arkansas Rowden 40.

[4]C. E. Spann farm, Altheimer, Ark. A sandy Arkansas river bottom loam; potash hunger present, but controlled by higher applications of potash; no root-knot noted. Variety: D. & P. L. 4

[5]M. G. Gardner farm, Wynne, Ark. Silt loam terrace soil; potash hunger present, but controlled in part at least by potash applications; no root-knot found. Variety: Arkansas Acala 37.

[6]Lawson Thomas farm, Paragould, Ark. Fine sandy St. Francis bottom loam; potash hunger present, especially on unfertilized checks; no root-knot noted. Variety: Arkansas Rowden 40.

[7]W. L. Edwards farm, Beech Grove, Ark. Cache river bottom soil; potash hunger present in severe form, controlled in part by potash applications; field very uneven in fertility and apparently also in drainage; no root-knot found. Variety: not named.

Examination of the roots of affected cotton plants revealed that in every case root-knot was a complicating factor. No consistent correlations from the point of view of cotton wilt control are to be noted, with possible exception of the plot fertilized with 600 pounds of 6-8-12 fertilizer, in which only 26.4 per cent of the plants were affected as compared to 35 per cent in the 6-8-4 plot. Yields did not appear to have been greatly influenced by potash fertilization, although the use of a 6-8-0 fertilizer gave a yield decidedly better than that of the check.

Certain facts concerning this test appear outstanding, *viz.*, that very little or no potash hunger was present, that little benefit appeared to result from the use of potash containing fertilizers, either from the point of view of cotton wilt control or yield, and finally that root-knot was present in a severe form. Workers with the cotton wilt disease since its discovery by Atkinson *(loc. cit.)* have noted that the presence of root-knot greatly increases the severity of cotton wilt attacks even to the extent of practically breaking down completely the resistance of even the most resistant varieties. It is reasonable to suppose that when root-knot is present, little benefit from the point of view of cotton wilt control may be expected as far as the use of potash fertilizers is concerned. Of all the demonstrations visited, this was the only one where root-knot was found to be a factor. In this particular case a wilt tolerant variety (Arkansas Rowden 2119) was used.

The tests at Scott, Arkansas, (Table 5, Section B) and at Altheimer, Arkansas, (Table 5, Section C) were also on Arkansas River bottom land, but the soil was apparently much less fertile in both cases than that at North Little Rock, since the plants were smaller and "rust" or potash hunger was severe on the non-potash plots. In both cases there was a striking decrease in the incidence of cotton wilt and a marked increase in yield in the 6-8-12 plot over the 6-8-0 plot. In both cases the cotton varieties used may be classed as fairly resistant to cotton wilt.

At Wynne, Arkansas, (Table 5, Section D) the conditions were very similar to those encountered at Scott and Altheimer. Potash hunger was very prevalent. The non-potash plots had made a poor growth, the plants had already become badly defoliated (late August), and the top bolls were opening prematurely (Figure 3). Differences in yields and percentages of cotton wilt were very outstanding, although the highest potash plots still had 21 per cent of wilted plants. The non-potash plots gave the highest wilt count, 54 per cent, noted anywhere in the state in 1930. The variety used, Arkansas Acala 37, is classed as partially wilt resistant.

Somewhat more extensive counts were made at Paragould, Arkansas, (Table 5, Section E). The soil was a sandy bottom soil and potash hunger was present in the non-potash plots and

controlled especially in the 6-8-8 and 6-8-12 plots. Although the greatest amount of cotton wilt found was only 23.79 per cent, there was a definite and clear-cut decrease to only 3.25 per cent in the 6-8-12 plot. Arkansas Rowden 40, a resistant variety, was used in this test.

The last test studied in 1930 was located at Beech Grove, Arkansas, on an alluvial Cache river bottom soil. The field seemed to be extremely uneven from the point of view of plant growth, and differences in the incidence of cotton wilt were not sufficient to warrant any conclusions. No root-knot complications were found, but "rust" was present to a certain extent in all plots. No explanation, except the extremely uneven nature of the plots, seems to point to the reason for failure to secure any control at all through the use of potash in this case (Figure 4).

The counts made in 1931 were conducted in much the same way as in 1930. Although the counts were made a month later than in 1930, the stage of growth of cotton was not essentially different, since the extreme drought of 1930 brought on very early maturity of cotton. Fertilizer applications were similar to those made in 1930 except that several tests were visited where no fertilizer was used except 100 pounds of muriate of potash per acre.

The tests at Forrest City, Palestine, and Wheatley, Arkansas, (Table 6, Sections A, B and C) were on silt loam soil, the two former being noted as N. E. Terrace silt loam and the latter as Crowley silt loam. Potash hunger was very evident in each case, and in each instance it was largely controlled by the application of potash. The incidence of cotton wilt was not excessively high in any case, but the effect of a 6-8-12 fertilizer in effectively cutting down the incidence of the disease from the 6-8-0 plots could not be doubted. Arkansas Rowden 40 and commercial Rowden were employed in these tests.

The tests at Colt, Wynne, Barton, and Marvell (Table 6, Sections D, E, F and G) were somewhat different from the others studied. In them only two plots were used, *viz.*, an unfertilized check plot and a plot fertilized with muriate of potash at the rate of 100 pounds per acre. The effect of muriate of potash could be seen in a very definite control of "rust" or potash hunger, in a tendency for the plants to remain in a green growing condition longer, and in a very distinct decrease in the amount of cotton wilt. At Colt and on the Childress farm at Marvell the decrease while marked was not sufficient for even good control, although sufficiently clear cut to leave no doubt as to the effect of muriate of potash. However, at Wynne and on the Franklin farm at Barton the control was somewhat better. The highest incidence of cotton wilt noted in 1931 was 60.8 per cent on the unfertilized plots on the Childress farm at Marvell. This is the

Figure 3. Plots at Wynne, Arkansas, [illegible] (Note the increased [illegible] 54 per cent of cotton wilt in the 6-8-0 plot in contrast to 21 per cent in the 6-8-12 plot.)

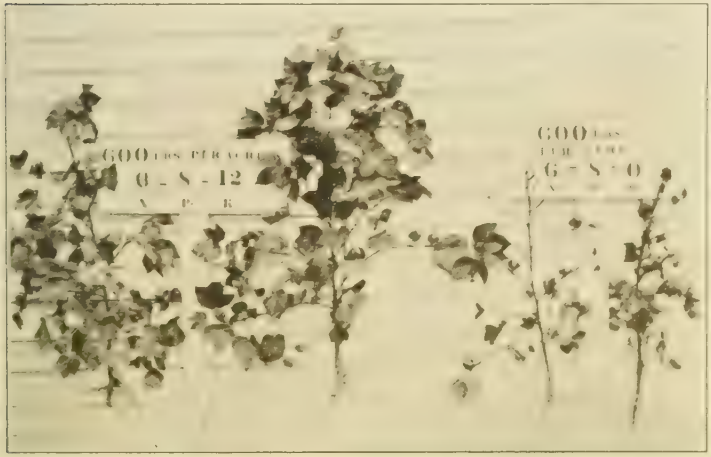

Figure 4. Healthy cotton plants and plants affected with "rust" or potash hunger, Beech Grove, Arkansas, August 30, 1930.

greatest amount of cotton wilt ever noted by the writers in Arkansas when root-knot was not present, and indicates that the conditions must have been unusually favorable for the development of the disease.

As has been previously noted the 1931 data shown in Table 6, include results from seven fertilizer tests, three of which consisted of applications of 600 pounds of 6-8-0 and 6-8-12 fertilizer and four of which consisted of no application and 100 pounds of muriate of potash per acre, respectively. In all cases the differences in the incidence of cotton wilt between the potash and no potash plots are sufficiently great to indicate defi-

TABLE 6. EFFECT OF FERTILIZER TREATMENTS ON THE INCIDENCE OF COTTON WILT AND ON THE YIELD OF SEED COTTON; DATA SECURED FROM COUNTS MADE ON FERTILIZER TESTS IN EASTERN AND NORTHEASTERN ARKANSAS, 1931[1]

Treatment	Plant count	Rate of cotton wilt	Yield of seed cotton per acre
	Number	*Per cent*	*Pounds*
Section A[2]			
6-8-0	387	16.00	1,020
6-8-12	315	6.34	1,464
Section B[3]			
6-8-0	101	20.70	420*
6-8-12	100	10.00	468*
*Very poor stand			
Section C[4]			
6-8-0	273	25.30	786
6-8-12	325	5.20	870
Section D[5]			
No fertilizer	251	32.60	608
100 lbs. Muriate of Potash per A.	151	20.50	720
Section E[6]			
No fertilizer	103	17.40	868
100 lbs. Muriate of Potash per A.	98	7.69	848
Section F[7]			
No fertilizer	327	28.10	820
100 lbs. Muriate of Potash per A.	457	5.90	1,092
Section G[8]			
No fertilizer	322	60.80	1,040
100 lbs. Muriate of Potash per A.	328	43.60	1,384

[1]All mixed fertilizer was applied at the rate of 600 lbs. (NPK) per acre,but in certain cases, muriate of potash was applied alone at the rate of 100 lbs. per acre. All fertilizer was placed in the row before planting. Counts made Sept. 30 and Oct. 1, 1931.

[2]L. B. Magness farm, Forrest City, Ark.; soil, N. E. terrace gray silt loam, some potash hunger present; no root-knot noted. Variety: Arkansas Rowden 40.

[3]Robert Ward farm, Palestine, Ark.; soil, N. E. terrace gray silt loam; potash hunger present; no root-knot noted. Variety: Arkansas Rowden 40.

[4]Claude Bondon farm, Wheatley, Ark.; soil, Crowley gray silt loam; potash hunger noted; no root-knot noted. Variety: Commercial Rowden.

[5]W. R. Rich farm, Colt, Ark.; soil, terrace silt loam; potash hunger present; no root-knot noted.

[6]J. W. Ballman farm, Wynne, Ark.; soil, N. E. terrace silt loam; potash hunger present; no root-knot noted.

[7]Smith Franklin farm, Barton, Ark.; soil, Lintonia silt loam; potash hunger present; no root-knot noted.

[8]P. L. Childress farm, Marvell, Ark.; soil, silt loam; potash hunger present; no root-knot noted. Variety: D. & P. L. 4.

nitely that the muriate of potash in the potash plots was the agent that brought about the reduction in the amount of cotton wilt noted. In each case the stimulatory effects of potash could also be noted in increased plant growth and in a very great amelioration of the condition known as "rust" or potash hunger (Figure 5). In some cases yield increases were outstanding, but in other cases, particularly at Palestine and Wynne, there was no benefit from potash from the point of view of yield. The low

Figure 5. Effect of 100 pounds of muriate of potash and no fertilizer, Barton, Arkansas, October 1, 1931. Note defoliation, decreased stand, and lessened vigor of plants in no fertilizer plot; 28.1 per cent of the plants in the no fertilizer plot was affected with cotton wilt in contrast to 5.9 per cent in the muriate of potash plot. "Rust" or potash hunger was severe in the no fertilizer plot.

yields at Palestine seem to be explained by a very poor stand, but no reason is apparent for the failure to show yield increases at Wynne, since the decrease in the incidence of wilt (nearly 10 per cent) should have been reflected in increased yield.

Comparison of Results

The very definite results from the point of view of cotton wilt control through the use of potash-containing fertilizers noted herein seem to be completely in accord with the early work in Arkansas reported by Rast (*loc. cit.*) and with the results reported by neal (*loc. cit.*) and Miles (*loc. cit.*) in Mississippi within recent years, but are at variance with results of Orton (1908), who stated that no benefit resulted from the use of commercial fertilizers and with those of Lewis (*loc. cit.*) in Georgia, who reported no benefits from the use of fertilizers in the con-

trol of cotton wilt. Lewis called attention especially to the fact that muriate of potash was of no benefit in controlling cotton wilt. Walker *(loc. cit.)* likewise found no benefits from the use of potash fertilizers for the control of cotton wilt in Florida.

Lewis also reported no benefits from the use of organic fertilizers in cotton wilt control, whereas Orton noted a certain amount of benefit from the use of manure, though apparently he did not consider it of great importance. Fulton, on the other hand, reported highly beneficial results from the use of stable manure in cotton wilt control. In contrast to all results secured in the United States, Fahmy *(loc. cit.)* reports that in Egypt cotton wilt is worst on the heavier fertile soils and that the use of manure tends to increase the incidence of the disease. The authors *(loc. cit.)* were unable to demonstrate any benefit from the use of green manures or calcium nitrate in the control of cotton wilt in the greenhouse.

The authors have not sufficient field data on the relation of stable manure to the incidence of cotton wilt to make any report at this time, although in a well-replicated series of experiments at Scott, Arkansas, in 1930 and 1931 stable manure at the rate of 10 tons per acre proved even more beneficial than fairly heavy potash applications in the control of "rust" or potash hunger. Since very little cotton wilt was present even on the checks at Scott, no relationship between the use of stable manure and cotton wilt control was indicated.

It thus appears that results obtained by Orton, Lewis, and Walker in the eastern cotton states, and those of Fulton in Louisiana are quite at variance with results secured on the sandy alluvial soils of Arkansas and Mississippi. This result need not necessarily be unexpected, since soils and weather conditions are extremely different in the two areas. In Arkansas the beneficial results of potash in preventing the development of cotton wilt are correlated with or at least coincident to a marked control of "rust", considerable stimulation of vegetative development, and in most cases to distinct benefits to the yield of cotton. The work of Neal and Miles indicates that the same is more or less true in Mississippi. It is not clear from the work of Orton, Lewis, and Walker that potash was particularly effective in the same way that it was in Arkansas and Mississippi with respect to "rust", increased vegetative vigor, and increased yields.

Lewis noted the severe injury resulting from combined attacks of the root-knot organism, *Caconema radicicola*, and the cotton wilt fungus, and it seems likely that all of his work on the relation of fertilizer applications to the development of cotton wilt was vitiated at least in part by the complication of severe attacks of root-knot. Practically everyone who has worked with cotton wilt in America has noted the effects of this disease in breaking down all the resistance of the cotton plant to cotton

wilt, and it appears to the authors that unless the root-knot factor is taken into account one cannot be certain of his grounds in any type of work with cotton wilt. Orton frequently mentions the root-knot disease in connection with his work with commercial fertilizers. Walker does not mention this matter in connection with his recent work in Florida. Furthermore, Walker used no unfertilized plots in his work but only various increments of potash in a mixed fertilizer, so that it is uncertain whether his lowest potash application was not sufficient to give all of the benefit that could be secured under the particular conditions of his experiment. Since the incidence of cotton wilt was very much higher than is commonly encountered in Arkansas, unless root-knot is present, it appears that the combination of soil and climatic factors present was very favorable for the development of this disease and might have even completely overshadowed any benefits which might have been secured from the use of potash fertilizers under less severe conditions.

The authors have no suggestion at the present time tending to explain the very marked benefits secured from the use of potash fertilizers nor of the failure of high applications of sodium nitrate and cottonseed meal to give similar results, except the noted fact that potash fertilizers even in low amounts and particularly in larger amounts gave a considerable measure of control of "rust" or potash hunger and provided considerable growth stimulus in most cases. Whether or not the fact that such plants remained in a green, vegetative condition much longer and grew more vigorously meant that their roots would be more efficient in "corking off" or otherwise combating the cotton wilt pathogen cannot be said at this time, but work in this connection is being continued by the authors.

The data from both the Cotton Branch Experiment Station and the various fertilizer tests visited seemed to indicate clearly that high applications of sodium nitrate alone, applications of fertilizers containing only nitrogen and phosphorus, and applications of cottonseed meal alone were quite inefficient from the point of view of cotton wilt control. In fact, there seemed to be some suggestion, at least, that cotton wilt was slightly more severe on plots fertilized with cottonseed meal alone than when no fertilizer was applied. Table 4 shows that the average percentage of cotton wilt for the 3 years, 1929, 1930, and 1931, on the checks was 23.7 per cent, on the buffer rows 24.1 per cent, and on the cottonseed meal plots 29.5 per cent. Likewise, the average percentage of cotton wilt on the 150 pounds of nitrate of soda plots and the nitrogen and phosphorus plots was higher than on the checks. The differences are probably not sufficient to warrant any sweeping conclusions but are suggestive when taken in conjunction with the assertions of Neal and Miles that unbalanced fertilizers, particularly those lacking potash, are

inefficient in relation to cotton wilt control in Mississippi. This work is being continued.

Another observation arising from the field studies on the various fertilizer tests visited in 1930 and 1931 was that in plots treated with a nitrogen-phosphorus fertilizer there was often more evidence of "rust" or potash hunger than on unfertilized checks, although in such cases the plants generally were somewhat larger on the fertilized than on the unfertilized plots.

Summary and Conclusions

High potash applications alone and fairly high potash applications in combination with nitrogen- and phosphorus-containing salts have given definite control of cotton wilt at points in central, eastern, and northeastern Arkansas.

High nitrate applications, applications containing nitrogen and phosphorus only, and applications of cottonseed meal alone were inefficient in cotton wilt control.

The control of cotton wilt through the use of potash-containing fertilizers seemed in nearly all cases to be correlated with or coincident to the control of "rust", stimulation of vegetative growth, and increased yields of seed cotton.

Recent work published by Ware, Young, and Janssen (1931) indicates that there are excellent long, medium, and short staple cottons which are either highly resistant or somewhat resistant to cotton wilt, some of which are suitable for all localities where cotton wilt is a problem in Arkansas. Therefore, it may be concluded that on those sandy alluvial soils where cotton wilt and "rust" are often found together in a severe form, a combination of a suitable wilt resistant variety of cotton and the judicious use of a fertilizer containing potash will prove the best possible solution of the cotton wilt problem now available.

It should be emphasized that root-knot infested soils must be freed of the root-knot nematode by proper rotations before the best results may be expected from any type of control for cotton wilt, and that since only a small area of the state has been studied from the point of view of cotton wilt control through the use of potash fertilizers, no widespread use of potash fertilizer for this purpose should be made until it is determined by small-scale trials whether the method is applicable to the particular locality under consideration.

LITERATURE CITED

Atkinson, Geo. F.

Some diseases of cotton: III. Frenching. Alabama Exp. Sta. Bul. 41: 19-29, illus. 1892.

Fahmy, T.

The Fusarium disease (wilt) of cotton and its control. Phytopathology 17: 749-767, illus. 1927.

Fulton, H. R.

Cotton wilt. La. Agr. Exp. Sta. Bul. 96: 5-15, illus. 1907.

Lewis, A. C.

Wilt disease of cotton in Georgia and its control. Ga. State Bd. Ent. Bul. 34, 31 p., illus. 1911.

Miles, L. E.

Cotton Diseases. Forty-second Ann. Rept. Miss. Agr. Exp. Sta. p. 22. 1929.

———

Forty-third Ann. Rept. Miss. Agr. Exp. Sta. p. 31. 1930.

Neal, D. C.

Cotton wilt: a pathological and physiological investigation. Ann. Mo. Bot. Gard. 14: 359-424, illus. 1927.

———

Cotton diseases in Mississippi and their control. Miss. Agr. Exp. Sta. Bul. 248, 30 p., illus. 1928.

———

Forty-first Ann. Rept. Miss. Agr. Exp. Sta. p. 37, 51. 1928.

Orton, W. A.

Sea Island cotton. U. S. Dept. Agr. Farmers' Bul. 302, 48 p., illus. 1907.

———

Cotton wilt. U. S. Dept. Agr. Farmers' Bul. 333, 24 p., illus. 1908.

Rast, L. E.

Control of cotton wilt by the use of potash fertilizer. Am. Soc. Agron. Jour. 14: 222-224, illus. 1922.

Rosen, H. R.

The control of cotton-wilt by the use of organic fertilizers. Science 65: 616-617. 1927.

Walker, M. N.

Potash in relation to cotton wilt. Florida Agr. Exp. Sta. Bul. 213, 10 p. 1930.

Ware, J. O., V. H. Young and George Janssen.

Cotton Wilt Studies. III. A study of the behavior of certain cotton varieties grown on soil artificially infested with the cotton wilt organism. Ark. Agr. Exp. Sta. Bul. 269. 1931.

Young, V. H., J. O. Ware and George Janssen.

Cotton Wilt Studies. II. Preliminary studies on wilt resistance and on the effect of certain soil factors on the development of cotton wilt. Ark. Agr. Exp. Sta. Bul. 234, 32 p., illus. 1929.

———————, ——————— ———————

A genetical, physiological, and pathological study of the cotton plant with special reference to wilt resistance. Forty-second Ann. Rept., Bul. 257 Ark. Agr. Exp. Sta. p. 73-75. 1930.

———————, ——————— ———————

A genetical, physiological, and pathological study of the cotton plant with special reference to wilt resistance. Forty-third Ann. Rept., Bul. 268 Ark. Exp. Sta. p. 59-60. 1931.

ACKNOWLEDGMENT

The authors desire to acknowledge the assistance of Winston Neely, T. C. Peele, and Glen Staten, formerly technical assistants, and R. A. Cody, technical assistant at the Cotton Branch Experiment Station.